

No-Till Cotton Yield Response to a Wheat Cover Crop in Mississippi

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Abstract

The rapid adoption of glyphosate-resistant cotton (*Gossypium hirsutum* L.) has presented growers with alternative technologies for no-till cropping systems. No-till cotton following a wheat cover crop was compared to no-till cotton without a cover crop in nine paired fields in Mississippi. A wheat cover crop was found to significantly increase the yield of no-till cotton an average of 11.96% or 110 lbs of lint per acre. The net value of the average response of no-till cotton to a wheat cover crop was estimated to be \$48.95/acre. Wheat as a cover crop improves the yield and profitability of no-till cotton.

Introduction

Cover crops grow during periods when the soil would otherwise be fallow. A cover crop may be defined as planted vegetation managed to protect and improve soil, crop, or water quality (8). Researchers often limit their work on cover crops to impacts on soil and water quality (6,8,12,13,14,18) or yield (1,2,5,15,17). Triplett et al. (19) examined the economics of no-tillage and tilled cropping systems but did not include cover crops in their study. No-till production systems, which include adequate winter ground cover, have the potential to reduce soil erosion by 90 to 95% of that for conventional (chisel or disk) tillage (18). This practice helps to satisfy mandated soil loss restrictions on many upland sites used for annual cotton production. Economic viability is a key question concerning the use of cover crops. With limited economic data, cover crops become just another costly recommendation. Growers can utilize both small plot and grower-scale demonstrations to make decisions on cover crops, but may be more willing to accept large-scale plot research, because such tests better reflect their time and equipment restraints.

Five mid-south studies have reported estimates of no-till cotton's yield response to a wheat cover crop. A 10-year Louisiana study (2) noted no-till that cotton yield following a wheat cover crop ranged from 22 to 99 lbs/acre and averaged 63 lbs (6.4%) of lint per acre greater than cotton grown under conventional tillage following volunteer winter cover (predominately broadleaf weeds in the mid-south). Similar results were reported for a 6-year Louisiana study (1) where yield improvement for no-till cotton following a wheat cover crop compared to conventional tillage following volunteer winter cover ranged from 31 to 122 lbs/acre and averaged 77 lbs (6.6%) of lint per acre. The yield increase in both Louisiana studies was not statistically significant.

During the last three years (1990 to 1992) of a five-year study in North Mississippi (18), no-till cotton following a wheat cover crop yield ranged from 123 to 256 lbs/acre and averaged 191 lbs (28.9%) of lint per acre more than cotton grown under conventional tillage following volunteer winter cover. Dabney (5) reported that the yield of no-till cotton following a wheat cover crop ranged from 52 to 172 lbs/acre and averaged 115 lbs (26.0%) of lint per acre more than cotton grown under conventional tillage following volunteer winter

cover, for the fifth consecutive year in a seven-year Mississippi study and continuing a previously reported trend (7). Triplett et al. (19) reported no-till cotton following a wheat cover crop in North Mississippi averaged 100 lbs (13.9%) of lint per acre more than no-till cotton following voluntary winter cover. The yield improvement in the three Mississippi studies was statistically significant.

There are a range of advantages to cover crops. Cover crops may improve soil properties (12,15) and soil productivity (6). They have been shown to enhance soil organic matter and provide food for soil macro and microorganisms (8). Cover crops can serve to moderate soil temperature, resulting in warmer minimum and cooler maximum temperatures (8). They can improve the growth rate of a subsequent crop (14), especially the seedling growth rate of cotton (9,12). Cover crops have been shown to enhance the fruiting rate of cotton (17). Cover crops can increase water infiltration, slow water runoff rate (6), and reduce soil loss (13). They minimize soil erosion and improve soil moisture retention in the subsequent crop (2). Cover crops have been shown to reduce contamination of surface water by reducing soil water erosion and movement of fertilizer nutrients and pesticides (1,6,8). Cover crops frequently suppress the growth of troublesome winter weeds, and improve the effectiveness and reduce the costs of weed control in the subsequent crop (5).

Cover crops must be terminated in a timely manner or unnecessary depletion of soil moisture will result (4). Water use by a cover crop can adversely impact yield of subsequent dryland crops in semiarid areas. Similarly, cooler maximum soil temperatures can retard early growth of subsequent crops grown near the cold end of their range of adaptation. Stand establishment problems associated with cover crop residue and suggested solutions have been reported (10). Increased levels of cutworms have been noted (11). Early maturity of the cotton crop is needed to allow timely seedbed preparation and planting of selected cover crops. Wheat as a cover crop avoids this problem in cotton because it can be applied by air prior to harvest.

The Roundup Ready (RR) technology (Monsanto Corporation), introduced in 1996, allows post-emergence application of glyphosate herbicides to the crop. In 2003, 77% of Mississippi's cotton acreage was planted to varieties containing RR technology (20). This technology provides alternative management strategies such as consideration of cover cropping and no-tillage production in situations where they previously were not practical. No-till cotton production begins with a burn-down herbicide application to control volunteer winter cover. No-till cotton production following a wheat cover crop begins with the same burn-down application to control the wheat cover crop and any volunteer winter cover. Post-emergence application of glyphosate herbicides controls weeds and grasses in the crop.

The objective of this study was to evaluate how wheat as a cover crop affects the yield and profitability of no-till cotton when grown on large blocks of commercial cotton.

Studies in Commercial Cotton Fields

Studies were conducted on commercial cotton fields in north-central Mississippi. A paired field experimental design was employed, and nine paired comparisons were made from 2000 to 2002. Two planting patterns were used. The first was the Mississippi standard method of cotton production, known as STD, where cotton is produced on raised beds, in equally spaced 38-inch rows (one row per bed) and planted with a regular planter. The second method is referred to as ultra-narrow-row (UNR) cotton. It is planted flat with a grain drill in equally spaced 7.5-inch rows. There is no expected yield difference (all else being equal) in the response of no-till cotton planted to a STD planting pattern to a wheat cover crop and the response of no-till cotton planted to a UNR planting pattern to a wheat cover crop. Hence, the data was pooled over planting patterns with the nine sets of paired fields as replications.

The paired field experimental design is similar to the more familiar split field experimental design. With the split field design the researcher is required to select a uniform field and randomly assigns the two treatments to the two parts (splits) of the same field. With the paired field design the researcher is required to select a uniform pair of fields and randomly assigns the two treatments to the two parts (fields) of the same pair of fields.

Similar fields of known size and with the same expected yield (based on field yield histories) were paired. In one field, cotton followed a wheat cover crop (Cover Crop Treatment). In the paired field, cotton of the same variety was planted on the same date to the same planting pattern and grown under the same fertility, weed control, and insect management practices, but did not follow a wheat cover crop (Check Treatment). All varieties in this study were of the Roundup Ready type. In all fields involved in this study, the previous harvested crop was no-till cotton. No-till cotton production begins in the spring with a burn-down herbicide application. In this study, the burn-down herbicide (always Monsanto branded Roundup in this study) application destroyed the wheat cover crop in the Cover Crop Treatment and any volunteer winter cover in the Check Treatment. Consequently, the only cost difference between the treatment was associated with hauling and ginning the difference in yields plus wheat seed and application costs.

Production (lbs of lint per field) was obtained from gin records. Yield (lbs of lint per acre) was calculated as production divided by field size (acres). The difference between paired field yields was tested with a paired different *t*-test, $P < 0.05$. Pairing eliminates a source of extraneous variance that exists from pair to pair. When members of the pair are positively correlated, pairing increases the ability of the experiment to detect smaller differences (16). This is accomplished by calculating the variance of the differences rather than that among the individuals within each sample.

Agronomic and Economic Analysis

Table 1 summarizes the paired treatment yield differences for three years and two planting patterns. Cotton producers in the study area experienced unfavorable weather and low cotton yields in 2000. Poor weather was responsible for the relatively low yield of both fields in Pair 1 in 2000. Producer 3 had less productive land (lower expected cotton yield) than Producers 1 or 2. Producer 3 applied a lower fertilizer N rate and tolerated greater weed pressure and insect damage than Producers 1 or 2. This largely explains why yields associated with data Pairs 8 and 9 were relatively lower than the yields associated with data Pairs 2 to 7. The nine paired differences of producing cotton with a wheat cover crop compared to no wheat cover all favor wheat cover crop. The difference ranged from 50 to 164 lbs/acre and averaged 110 lbs of lint per acre. The difference is statistically significant (calculated $t = 6.436$ at $df = 8$; tabular $t = 2.306$ at $df = 8$, $\alpha = 0.05$).

Table 1. Yield (lbs of lint per acre) and net returns (\$/acre) for no-till cotton following a wheat cover crop compared with no-till cotton without a previous cover crop for two different planting patterns in 9 paired field comparisons in Mississippi, 2000-2003.

Paired comparison	Year	Producer	Planting pattern	Wheat cover crop	Check	Diff.	Net returns
1	2000	1	STD	755	625	130	60.48
2	2001	1	STD	1,190	1,030	160	77.80
3	2001	1	UNR	878	726	152	73.18
4	2002	1	STD	1,071	1,009	62	21.21
5	2002	1	UNR	952	894	58	18.90
6	2002	2	STD	932	768	164	80.11
7	2002	2	UNR	986	830	156	75.49
8	2002	3	STD	765	710	55	17.16
9	2002	3	UNR	750	700	50	14.28
Average				920	810	110	48.93

STD = standard method of production; cotton is planted on raised beds in equally spaced 38-inch rows.

UNR = ultra narrow row method of production; cotton is planted flat in equally spaced 7.5-inch rows.

Although agronomic performance of no-till cotton is important, the value of the added yield must be evaluated relative to the added cost of the practice. The cost of a wheat cover crop was estimated to be \$0.12/lb for wheat planting seed and \$5.00/acre for the seeding operation (3). Mississippi growers have been varying the seeding rate from 50 to 80 lbs depending on the seeding method (ground or air) and other factors (primarily soil type and slope). Eighty lbs/acre was utilized to calculate the cost of wheat planting seed for this economic comparison.

At a price of \$0.60/lb of lint and \$0.05/lb of cottonseed and using an assumption of 1.55 lbs of cottonseed per lb. of cotton lint (3), the value of the average yield response from this study (110 lbs/acre of cotton lint) would be \$74.53/acre. Eighty pounds of wheat planting seed plus application cost was estimated to be \$14.60/acre. The cost of hauling (\$0.02/lb of lint) and ginning (\$0.08/lb of lint) the additional 110 pounds was \$11.00. The net value of the average response to a wheat cover crop was therefore \$48.93/acre. The net value of the smallest yield response observed (50 lbs of lint per acre) was \$33.88 minus 14.60 minus 5.00 or \$14.28/acre. Based on the 2000-2002 results in Mississippi, and the literature reviewed, no-till cotton following a wheat cover crop appeared to be profitable in each of the nine paired-field comparisons.

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